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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/624,662	07/22/2003	Kunal Taravade	03-0442	7008

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EXAMINER

ROSASCO, STEPHEN D

ART UNIT	PAPER NUMBER
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1756

DATE MAILED: 05/02/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/624,662	Applicant(s) TARAVADE ET AL.	
	Examiner Stephen Rosasco	Art Unit 1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 July 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-7 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-7 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 22 July 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>7/22/03</u> . | 6) <input type="checkbox"/> Other: _____ |

Detailed Action

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-7 are rejected under 35 U.S.C. 102(b) as being anticipated by Kim (5,789,116) or Moon et al. (5,853,921)

The claimed invention is directed to a phase shift mask comprising: a quartz substrate which includes an etch depth that corresponds to a 180 phase shift; and a pattern on the quartz substrate, wherein the pattern has a thickness which corresponds to at least one of a 0 and 360 degree phase shift.

And wherein the pattern comprises an attenuated film.

And wherein the pattern comprises MoSi.

And a method comprising: providing a quartz substrate having a pattern thereon having a thickness which corresponds to at least one of a 0 and 360 degree phase shift; and etching the quartz substrate to a depth that corresponds to a 180 phase shift.

Kim teaches (see claims) a method for fabricating a phase shift mask, comprising the steps of: forming a semitransparent phase shifter film on a substrate which is transparent with respect to exposure light;

forming a material film having a light shielding function on the phase shifter film;

forming a material film pattern by patterning the material film; forming a semitransparent phase shifter pattern by etching the semitransparent phase shifter film using the material film pattern as an etchings mask;

forming a transparent phase shifting groove by etching the transparent substrate using the material film pattern and the semitransparent phase shifter pattern as an etching mask; and completing a light shielding film pattern by further patterning the material film pattern on the semitransparent phase shifter pattern.

And wherein the step of forming a semitransparent phase shifter film comprises the step of: forming the semitransparent phase shifter film with a material selected from the group consisting of MoSiON, SiNsubx, amorphous carbon, and CrF.

And wherein the step of forming a material film having a light shielding function comprises the step of: forming the material film having a light shielding function with a material selected from the group consisting of chromium (Cr), aluminum (Al) and MoSi.

And wherein the step of forming the transparent phase shifting groove comprises the step of: forming the transparent phase shifting groove to a depth of D from the substrate surface so that a phase difference ($\Delta\phi$) between

exposure light passing through the transparent phase shifting groove and that passing through the semitransparent phase shifter pattern ranges between 90 and 270 degrees.

And wherein the depth D is determined by the following equation:

$$D = [\lambda / 2(N-1)] - [2(n-1)d / 2(N-1)].$$

Moon et al. teach (see claims) a method of fabricating a phase shift mask having wider phase shifting trenches than non-phase shifting openings, comprising the steps of: forming a radiation-blocking layer on a phase shift mask substrate; forming a photoresist layer on the radiation-blocking layer; exposing first portions of the photoresist layer at a first exposure dose, and second portions of the photoresist layer at a second exposure dose that is greater than the first exposure dose such that the second portions of the photoresist layer are wider than the first portions of the photoresist layer; etching the radiation blocking layer using the photoresist layer as an etch mask, to thereby produce first apertures in the radiation blocking layer beneath the first portions of the photoresist layer and second apertures in the radiation blocking layer which are wider than the first apertures, beneath the second portions of the photoresist layer; the first apertures forming non-phase shifting openings on the phase shift mask substrate; and etching the phase shift mask substrate beneath the second apertures, to thereby

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produce phase shifting trenches in the phase shift mask substrate that are wider than the non-phase shifting openings in the phase shift mask substrate.

Moon et al. also teach (col. 5, lines 16-23) referring to FIG. 3, a radiation (e.g. light) blocking layer 320 is formed on a phase shift mask substrate 310, for example, quartz, to a predetermined thickness by depositing chrome, chrome oxide, or MoSi. Sputter deposition or plasma deposition may be used to deposit the radiation blocking layer 320. Then, a first photoresist layer 330 is formed on the radiation blocking layer 320 by spin coating an electron beam resist to a predetermined thickness.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-7 are rejected under 35 U.S.C. 102(e) as being anticipated by Tsai et al. (6,458,495) or Kalk (6,780,548).

Tsai et al. teach a method of fabricating a phase-shifting mask for use with light at a wavelength comprising: a substrate, said substrate formed from a transparent material, said substrate having a first thickness, said substrate comprising a first region, a second region, and a third region, forming an opaque

layer on said substrate, using a first etch to remove said opaque layer in said first region and said second region, using a second etch to form a first trench in said first region by reducing said substrate to a second thickness such that light at said wavelength transmitted through said first region is shifted in phase by 180 degrees relative to said first thickness, said first trench having an upper width and a lower width, and using a third etch to make said lower width larger than said upper width in said first trench, said third etch also forming a second trench in said second region.

Tsai et al. also teach (col. 3, line 52 to col. 4, line 16) that the layer 505 is an absorber of light at the illumination wavelength. It typically comprises chrome of sufficient thickness to be opaque. The layer 505 is formed from Chromium (Cr), usually in a graded or multilayer structure. Oxygen (O) and Nitrogen (N) are included towards the upper surface to reduce reflection when the mask is used in a wafer stepper. Oxygen (O) is included towards the lower surface to improve adhesion to the substrate 507. The layer 505 may also be formed from refractory metals, such as Tungsten (W), metal silicides, such as Molybdenum Silicide (MoSi).

Kalk teaches a method for fabricating a phase shifting mask, the method comprising: providing an etched transparent substrate having a recessed transmissive portion, the etched substrate having a first refractive index; depositing an absorber layer on the etched substrate; patterning the absorber layer; and forming a single transmission balancing layer on the resulting patterned

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absorber layer, the transmission balancing layer having a second refractive index greater than the first refractive index and being substantially transparent to at least one wavelength comprising an etched transparent substrate

wherein the substrate has a first refractive index and the transmission balancing layer has a second refractive index greater than the first refractive index.

Kalk also teaches that in some embodiments, the optical absorbers may be a partially transmissive material, such as molybdenum silicide (MoSi), which has a transmissivity of approximately one percent to approximately thirty percent.

Conclusion

Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Stephen Rosasco whose telephone number is (571) 272-1389. The Examiner can normally be reached Monday-Friday, from 8:00 AM to 4:30 PM. The Examiner's supervisor, Mark Huff, can be reached on (571) 272-1385. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



S. Rosasco
Primary Examiner
Art Unit 1756

S. Rosasco
04/19/05